(19)日本国特許庁（JP）　　(12) 公開特許公報（A）　　(11)特許出願公開番号

特開平9－233869

(43)公開日　平成9年(1997)9月5日

(51)Int.Cl.^{6}	識別記号	庁内整理番号	FI	技術表示箇所
H02N　2/00			H02N　2/00	C
B06B　1/06			B06B　1/06	Z

審査請求　未請求　請求項の数4　OL　（全10頁）

(21)出願番号　特願平8－36528

(22)出願日　平成8年(1996)2月23日

(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子3丁目30番2号

(72)発明者　赤田　弘司
東京都大田区下丸子3丁目30番2号キヤノン株式会社内

(72)発明者　杉森　正巳
東京都大田区下丸子3丁目30番2号キヤノン株式会社内

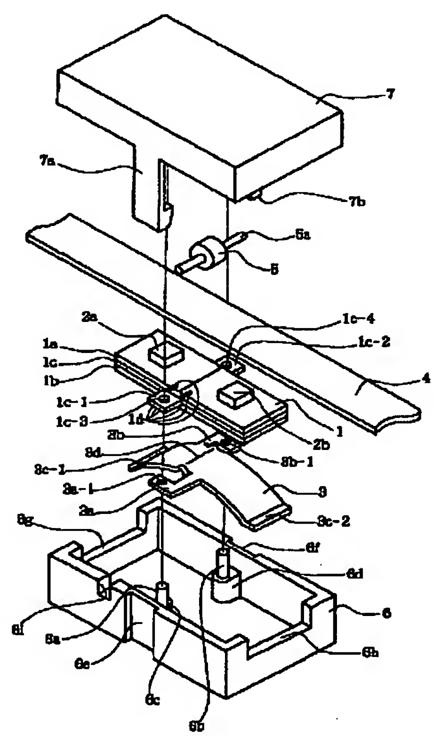
(74)代理人　弁理士　丸島　儀一

(54)【発明の名称】　振動装置

(57)【要約】

【課題】　振動体の上下方向に変位する振幅だけを検出したのでは、安定した駆動特性で速度制御することが難しい。

【解決手段】　振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させて接触体との相対移動を得る振動装置において、前記振動体の屈曲振動と縦振動の振幅を検出する検出手段を設けたことを特徴とし、楕円運動の楕円軌道の形を変えることにより、正確な速度制御を可能とした。



【特許請求の範囲】

【請求項１】　電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、

前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段を設けたことを特徴とする振動装置。

【請求項２】　電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、

前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段と、

前記検出手段の出力に基づき前記変換素子の複数の信号入力部への供給信号の強さのバランスを変える制御手段を設けたことを特徴とする振動装置。

【請求項３】　電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、

前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段と、

前記検出手段の出力に基づき前記変換素子の複数の信号入力部への供給信号の位相を変える制御手段を設けたことを特徴とする振動装置。

【請求項４】　前記振動体は前記屈曲振動の節となる位置が複数箇所できるように前記変換素子は配設され、前記複数の節の位置に機械－電気エネルギー変換の為の前記複数の信号出力部を配置し、前記信号出力部からの出力に基づき前記屈曲振動及び縦振動の振幅を検出したことを特徴とする請求項１，２または３記載の振動装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、振動を利用した振動装置に関するものである。

【０００２】

【従来の技術】従来、この種のモータとしては、例えば特開昭６１－２５１４９０号、特開昭６１－３５１７６、特開平６－１３３５６８号公報に開示されるものがあった。これらの公報によれば、進行波タイプの超音波モータで弾性体の振動振幅をセンサ相等を設けることにより検出し、入力周波数を変化させたり、入力電圧を制御したりすることで安定な駆動特性を得ようとする装置であった。

【０００３】

【発明が解決しようとする課題】しかしながら、これらの装置は実際に振動体が行っている楕円運動の振幅は検出できても楕円の形状は検出できない。例えば周波数を可変すると、楕円の振幅が小さくなったのか、楕円の形状が変化したのか判断することができない。また、超音波モータの速度を制御するために入力周波数を変化させることが行われるが、周波数によっては突然加速したり停止してしまうなどの不安定な要素も考えられる。

【０００４】また、定在波型の超音波モータにおいても、上下方向に変位する振動子の振動の振幅だけを検出していたのでは安定した駆動特性で速度制御することが難しい。

【０００５】

【課題を解決するための手段】請求項１の発明は、電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段を設けた振動装置を特徴とする。

【０００６】請求項２の発明は、電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段と、前記検出手段の出力に基づき前記変換素子の複数の信号入力部への供給信号の強さのバランスを変える制御手段を設けた振動装置を特徴とする。

【０００７】請求項３の発明は、電気－機械エネルギー変換素子と弾性体を積層してなる振動体と、前記変換素子の複数の信号入力部に位相の異なる交番信号を供給し、前記振動体を屈曲振動と縦振動させて両振動の合成により作用部を楕円運動させ、前記振動体に接触した接触体と前記振動体とを相対移動可能とする振動装置において、前記振動体の前記屈曲振動と前記縦振動の振幅を検出する検出手段と、前記検出手段の出力に基づき前記変換素子の複数の信号入力部への供給信号の位相を変える制御手段を設けた振動装置を特徴とする。

【０００８】請求項４の発明は、前記振動体に前記屈曲振動の節となる位置が複数箇所できるように前記変換素子は配設し、前記複数の節の位置に機械－電気エネルギー変換の為の複数の信号出力部を配置し、前記信号出力部からの出力に基づき前記屈曲振動及び縦振動の振幅を検出した振動装置を特徴とする。

【０００９】

【発明の実施の形態】

（実施例）図１において１は振動体で、リン青銅、黄銅等で板状に形成された弾性体１ｃの両主面に、一対の板状のエネルギー変換素子としての圧電素子１ａ，１ｂが加圧接着されている。また、振動体１の両主面にはニッケル、銅等の導電材料が蒸着され、電極層が形成されている。電極層は振動体１の長手方向を２分する位置に絶縁分割して形成されており電気ー気化エネルギー変換の為の信号入力部となる４つの電極部１ｅ～１ｈからなっている。さらに、電極部１ｇ，１ｈには、図２が示すように、機械ー電気エネルギー変換の為の信号出力部となるセンサ電極部１ｇ－１，１ｈ－１および絶縁部１ｇ－２，１ｈ－２が形成されてセンサ電極部１ｇ－１，１ｈ－１と電極部１ｇ，１ｈとはそれぞれ非導通となっている。またセンサ電極部１ｇ－１，１ｈ－１の主要部の位置は、後述の駆動子の貼付位置の真裏面に形成されている。またセンサ電極部１ｇ－１，１ｈ－１は主要部の一部分から振動体１の振動モードの節部近傍（振動体１の長手方向中央付近）へ導かれている。弾性体１ｃには張り出し部１ｃ－１，１ｃ－２があり、この張り出し部の中央部に係合穴１ｃ－３，１ｃ－４が設けられている。張り出し部の位置は振動体１の振動モードの節部近傍となっており、振動モードへの悪影響を回避している。さらに電極部１ｅ～１ｈおよびセンサ電極１ｇ－１，１ｈ－１および弾性体１ｃには合計７本の端子部１ｄが半田付け等により取り付けられている。それらの位置は前述と同様の理由により節部近傍となっている。

【００１０】２ａ，２ｄはフェノール樹脂、エポキシ樹脂等で形成された１対の駆動子であり、より高い駆動力を得るために振動体の振動モードの腹部の位置に接着等により取り付けられる。

【００１１】３はリン青銅等で形成された加圧バネで、張り出し部３ａ，３ｂが形成され、その張り出し部にはそれぞれ係合穴３ａ－１，３ｂ－１が設けられている。また加圧バネ３の長手方向両端部には折り曲げ部３ｃ－１，３ｃ－２が設けられている。さらに加圧バネ３の中央部には、幅方向に凸部３ｄが形成されている。

【００１２】４はステンレス鋼等で形成された接触体としてのガイドレールである。

【００１３】５はローラで、ローラを支持する支持棒５ａが圧入等の周知の方法で取り付けられている。

【００１４】６はプラスチックモールド加工されたケースで、係合軸部６ａ，６ｂが設けられ、それらの根元にはストッパ６ｃ，６ｄが設けられている。またケース６の長手方向両端上部にはガイドレール４よりもやや大きい幅を持つ溝部６ｇ，６ｈが設けられている。またケース６の一部に溝部６ｉが設けられている。さらにケース６の幅方向両端部には溝部６ｅ，６ｆが設けられている。

【００１５】７はプラスチックモールド加工されたキャップで、支持棒５ａを軸支する軸受溝（不図示）と係合軸部６ａ，６ｂが挿入される穴部（不図示）が設けられている。さらにキャップ７の幅方向両端部には係止爪を有した挟持片７ａ，７ｂが設けられている。

【００１６】次に各部品の相互関係について説明する。

【００１７】ケース６に設けられた係合軸部６ａ，６ｂにそれぞれ加圧バネ３に設けられた係合穴３ａ－１，３ｂ－１係合（挿入）させる。そのとき加圧バネ３の張り出し部３ａ，３ｂがやや係合軸方向に折り曲げられており、係合軸部６ａ，６ｂと係合穴３ａ－１，３ｂ－１の嵌合ガタをなくしている。そして折れ曲がり部３ｃ－１，３ｃ－２がケースの底面に接触するまで加圧バネ６はスライドされて止まる。加圧バネ６の最大たわみ量は張り出し部３ａ，３ｂがケース６のストッパ６ｃ，６ｄに突き当たるまでたわむようになっている。

【００１８】つぎに振動体１の弾性体１ｃに設けられた係合穴１ｃ－３，１ｃ－４にそれぞれケース６の係合軸部６ａ，６ｂを挿通する。そのとき張り出し部１ｃ－１が係合軸方向に若干折り曲げられており、係合軸６ａ，６ｂと係合穴１ｃ－３，１ｃ－４の嵌合ガタをなくしている。そして振動体１の圧電素子１ｂに加圧バネ３の凸部３ｄに接触するまで、振動体１がスライドされる。

【００１９】ローラ５に圧入等の方法で取り付けられた支持棒５ａの両端部がキャップ７に設けられた軸受部（不図示）に装着固定される。

【００２０】加圧バネ３と振動体１が取り付けられたケース６と、ローラ５が取り付けられたケース７が、ローラ５の面と駆動子２ａ，２ｂの面でガイドレール４を挟みこむようにして取り付けられる。その際に、キャップ７に設けられた係止爪を有する挟持片７ａ，７ｂがケース６の溝６ｅ，６ｆにガイドされて、スナップフィットにより取り付けられる。またそのときに、ケース６の係合軸６ａ，６ｂとキャップ７に設けられた穴部（不図示）と係合しキャップ７がケース６と位置決めされる。さらにガイドレール４はケース６の溝６ｇ，６ｈにより幅方向への移動が規制される。

【００２１】電極部１ｅ～１ｈ、センサ電極部１ｇ－１，１ｈ－１及び弾性体１ｃに設けられた端子部１ｄはリード線もしくはフレキシブルプリント基板に半田付けされ、リード線もしくはフレキシブルプリント基板がケース６に設けられた溝６ｉよりケース６の外部へ引き出され、リード線もしくはフレキシブルプリント基板を外部の駆動回路に結線することによって、給電とセンシングが可能となる。

【００２２】本実施の形態の振動装置の駆動原理について説明する。

【００２３】図３は、圧電素子の圧電効果を示した図である。同図において１０は圧電素子で、図の上方から下方へ分極処理がなされている（図中矢印の方向）。また、圧電素子の両面には電極部１０ａ，１０ｂが蒸着処

理により施されている。

【0024】図3（a）は、電極部10aに＋電位、電極部10bに－電位を印加したときの様子を示した図である。この場合圧電素子には、電極部10aから電極部10bの方向つまり分極方向と順方向に電界が印加されるので圧電素子は分極方向に対して垂直の方向に伸び、電界の大きさに応じた伸び量が発生する。

【0025】図3（b）は電極部10aに－電位、電極部10bに＋電位を印加したときの様子を示した図である。この場合圧電素子には、電極部10bから電極部10aの方向つまり分極方向と逆方向に電界が印加されるので圧電素子は分極方向に対して垂直の方向に縮み、電界の大きさに応じた縮み量が発生する。

【0026】図3（c）は圧電素子を分極方向に対して垂直方向に、外力により伸ばしたときの様子を示した図である。この場合は電極部10aに＋電位、電極部10bに－電位が生じ、伸び量に応じた電位差が発生する。

【0027】図3（d）は圧電素子を分極方向に対して垂直方向に、外力により縮めたときの様子を示した図である。この場合は電極部10aに－電位、電極部10bに＋電位が生じ、縮み量に応じた電位差が発生する。

【0028】本実施の形態の振動装置の振動体はこれらの圧電現象を利用して駆動子に楕円運動が発生するように定在波を励起しようとしたものである。

【0029】図4は振動装置の振動体の側面図である。圧電素子1aは図の下方から上方へ分極処理が施され、圧電素子1bは図の上方から下方へ分極処理が施されている。また、弾性体1cはグラウンドに接続されている。このように構成された振動体1に、図5に示すように電極部1eと1hに同位相、同振幅の交番電圧V_Aを印加し、電極部1fと1gに同位相、同振幅の交番電圧V_Bを印加（ただし、電極部1eと1hへの交番電圧とは位相が異なる）すると、圧電効果によって振動体が種々の挙動を繰り広げる。たとえば図5の時間t_1における圧電振動子の挙動は、電極部1e～1hには同値で＋の電圧が印加されるので、図6（c）が示すように縮みが生じる。図5の時間t_2における圧電振動子の挙動は、電極部1e，1hには＋の電圧が印加され、電極部1f，1gには－の電圧で電極部1e，1hへの印加電圧と絶対値が同値の電圧が印加されるので、図6（d）が示すように屈曲する。

【0030】図5の時間t_3における圧電振動子の挙動は、電極部1e～1hには同値で－の電圧が印加されるので、図6（a）が示すように伸びが生じる。図5の時間t_4における振動体の挙動は、電極部1e，1hには－の電圧が印加され、電極部1f，1gには＋の電圧で電極部1e，1hへの印加電圧と絶対値が同値の電圧が印加されるので、図6（b）が示すように屈曲する。

【0031】以上のことから連続的な時間で挙動を見ると、振動体は伸縮運動（縦振動）と屈曲運動（横振動）が合成された挙動を示し、駆動子2a，2bは楕円軌道を描くことになる。そして駆動子2a，2bの楕円軌道の回転方向は一致している。また、交番電圧V_AとV_Bの位相を逆転させると楕円軌道の回転方向は上記方向と逆方向になる。

【0032】以上のようにして楕円運動を行う駆動子2a，2bにガイドレール等の摺動部材を押圧すると、駆動力が発生し、ガイドレール等の摺動部材と駆動子とが相対的に移動可能となる。ガイドレールを固定すれば、当然ながら振動体が移動することになる。又、その逆も実施できる。

【0033】本発明の振動装置の、横振動と縦振動の検出方法について説明する。

【0034】圧電効果により圧電素子が変形するとその変形量に応じた圧電が発生することは上述した。そこで振動装置の振動体に、駆動用電極とは別に圧電素子の変形量を監視できるセンサ電極部を設け、横振動と縦振動を検出する方法を考えた。横振動（屈曲振動）の任意の時間での大きさは、任意の時間での電極部1eと1hへの印加電圧による圧電素子の伸び量（もしくは縮み量）と電極部1fと1gへの印加電圧による圧電素子の縮み量（もしくは伸び量）で決まる。つまりセンサ電極部1h－1の出力電圧S_Aとセンサ電極1g－1の出力電圧S_Bの差で表現することができる。

【0035】また縦振動の任意の時間での大きさは、任意の時間での電極部1eと1hへの印加電圧による圧電素子の伸び量（もしくは縮み量）と電極部1fと1gへの印加電圧による圧電素子の縮み量（もしくは伸び量）で決まる。つまりセンサ電極部1h－1の出力電圧S_Aとセンサ電極1g－1の出力電圧S_Bの和で表現することができる。

【0036】図7は振動体1の電極部1e，1hに図5に示す交番電圧V_Aを印加し、電極部1f，1gに図5に示す交番電圧V_Bを印加したときの、センサ電極部1g－1の出力電圧S_Bとセンサ電極部1g－1の出力電圧S_Aおよび横振動を表すS_A-S_Bと縦振動を表すS_A+S_Bの電圧波形を示している。

【0037】S_A+S_Bを横軸、S_A-S_Bを縦軸にとり、時間に沿って曲線を描かせると図8のようになる。この曲線は正しく、駆動子の楕円軌道を表現したものである。

【0038】以上のように、センサ電極部1h－1の出力電圧S_Aとセンサ電極部1g－1の出力電圧S_Bを検出することで、横振動と縦振動の挙動がわかり、駆動子の楕円軌道が表現できることがわかる。

【0039】ところで、楕円運動の波頭の接線速度は、楕円軌道の形状によって異なる。たとえば、図9（a）の楕円軌道のP_1点での接線速度に対して、図9（b）の楕円軌道のP_2点での接線速度は遅くなり、図9（c）の楕円軌道のP_3点での接線速度は速くなる。し

たがって、図９の楕円軌道が駆動子の動きだとするならば、楕円軌道の形状を変化させせることによって、ガイドレール等の摺動部材との相対速度を変化させせることができるということである。

【００４０】そこで、電極部　１ｅ，１ｈへの印加交番電圧V_Aと、電極部１ｆ，１ｇへの印加交番電圧V_Bの位相差および振幅比を変えることで、駆動子の楕円軌道の形状を変化させ、摺動部材との相対速度を変化させることを考えた。

【００４１】まず、V_AとV_Bの振幅を一定（S_AとS_Bの振幅も原理的に一定）にして、位相差を変化させたときの楕円軌道を描かせると、図１０～１２のようになる。

【００４２】図１０におけるV_AとV_Bの位相差をα（S_AとS_Bのの位相差も原理的にα、０°＜α＜１８０°）、図１１におけるV_AとV_Bの位相差をβ（S_AとS_Bの位相差も原理的にβ、０°＜β＜１８０°）、図１２におけるV_AとV_Bの位相差をγ（S_AとS_Bの位相差も原理的にγ、０°＜γ＜１８０°）とすると、β＞αとすることによって、楕円軌道の形状は位相差αのときとくらべて縦長になる。また、γ＜αとすることによって、楕円軌道の形状は位相差αのときとくらべて縦長となる。

【００４３】以上のことから、V_AとV_Bの振幅を一定にして、位相差を変化させると、楕円軌道の形状が変わり、楕円軌道の波頭の接線速度が変化する。つまり、駆動子の楕円軌道の接線速度を変化させ、ガイドレール等の摺動部材との相対速度を任意に変化させることができる。

【００４４】つぎに、V_AとV_Bの位相差を９０°に設定し、V_AとV_Bの振幅比を変化させると、図１３、図１４、図１５のようになる。

【００４５】印加交番電圧の振幅に応じたセンサ電極部の出力電圧S_AとS_Bの振幅を、図１３においてそれぞれa_1，b_1、図１４においてそれぞれa_2，b_2、図１５においてa_3，b_3とする。

【００４６】$|a_1|=|a_2|=|a_3|=|b_1|>|b_2|>|b_3|$となるように印加交番電圧の振幅を調整して、各々の楕円軌道を比較すると、b_1のときとくらべて、b_2のときの楕円軌道の形状はやや細長くなる。また、b_3の場合はさらに細長い形状になる。

【００４７】以上のことから、V_AとV_Bの位相差を９０°に設定し、V_AとV_Bの振幅比を変化させると、楕円軌道の形状が変わり、楕円軌道の波頭の接線速度が変化する。つまり、駆動子の楕円軌道の接線速度を変化させ、ガイドレール等の摺動部材との相対速度を任意に変化させることができる。

【００４８】次に制御に関する構成を示す。

【００４９】図１６は、本発明の実施の形態を示す回路ブロック図である。

【００５０】発振器２１から出力された駆動周波数より高い高周波信号を分周器２２，２３に所定の周波数に分周し、駆動周波数に変換してドライバＡ２４，ドライバＢ２５に出力する。ドライバＡ２４，Ｂ２５は、分周器から得た信号を増幅して超音波モータ１に印加する（具体的には上述したように圧電素子の電極部へ印加されるものである）。また、超音波モータに信号が印加されると、コイル２４ａとコイル２５ｂと圧電素子の間で共振し、ドライバＡ２４，Ｂ２５へ入力した電圧より高い電圧が圧電素子に印加されることになる。この時の圧電素子の挙動に応じたセンサ電極部からの出力電圧を検出し、加算回路２７によってＡ＋Ｂを行い縦振動を検出し、減算回路２８によってＡ－Ｂを行い屈曲（横）振動を検出する。検出された縦振動と屈曲（横）振動は、位相比較器２９と振幅比較器３０に送られそれぞれ比較した結果をマイクロコンピュータ２６に出力する。マイクロコンピュータ２６は、入力した位相差と振幅差から楕円の挙動を判断し、移相器３１、ドライバＢ２５にそれぞれ楕円の挙動を調整するように信号を出力する。

【００５１】例えば、振幅比較器３０は図１７（ａ）の様にサイン波関数で示されるＡ＋Ｂ、Ａ－Ｂの信号をそれぞれ半波整流し、直流成分に変換して振幅値に変換しマイコン２６でＡ／Ｄ変換を行い比較する。

【００５２】そこで、得られた振幅比より移相器３１によって入力信号ＡとＢの位相差を変える。例えば、図１８の様に発振器２１からのクロックをカウンタＡ２２ａ，カウンタＢ２３ａに入力する前にカウンタＢ２３ａの方の初期値を設定しカウンタＡ２２ａとの位相差を設定する。この後、クロックをカウンタＡ，Ｂに入力し所定の比較値と比較し一致したらカウンタＡ，Ｂをクリアする。これによって初期値分、常に位相がずれることになる。比較器Ａ、Ｂ２２ｂ，２３ｂから得られた信号を分周器２２ｃ，２３ｃで分周しデューティー比５０％の矩形波に変換してドライバＡ２４，ドライバＢ２５に出力する。これによって駆動信号の位相差を任意に変更することができる。

【００５３】また、位相比較器２９は図１７（ｂ）の様にＡ＋Ｂ、Ａ－Ｂをヒステリシスコンパレータで基準値と比較し矩形波に変換する。変換された矩形波をＥＸＯＲ２９ｃを通し位相差分の時間だけＯＮする信号を作り、その時間内のマイコン内の基準クロックの数によって位相差を判断することができる。

【００５４】また、得られた位相差より、マイコン２６はドライバＢ２５に印加される電圧を変更して楕円の挙動を調整する。例えば、ドライバＢの電源はＤＣ／ＤＣコンバータ２５ａによって決定している。この場合、ＤＣ／ＤＣコンバータの出力する電圧を制御するために図１９のコンパレータ２６ｂによって出力する電圧をマイコンの出力する電圧で制御することができる。

【００５５】上記の説明により、実際に楕円の挙動（軌跡）を調整することが可能となり、超音波モータの速度

制御を安定して行うことができる。

【０　０５６】

【発明の効果】請求項１の発明によれば、振動体の楕円運動の挙動を正確に検出することができ、良好な駆動性能を得る為の制御を可能とすることができる。

【０　０５７】請求項２の発明によれば、振動体の楕円運動の挙動を正確に検出することができ、更にはその検出結果により楕円運動の楕円軌道の形を変えることにより速度制御が可能となる。

【０　０５８】請求項３の発明によれば、振動体の楕円運動の挙動を正確に検出することができ、更にはその検出結果により楕円運動の楕円軌道の形を変えることにより速度制御が可能となる。

【０　０５９】請求項４の発明によれば、振動体の屈曲振動と縦振動とを正確に検出することができる。

【図面の簡単な説明】

【図１】本実施の形態の振動装置の構成を示す分解斜視図。

【図２】図１の振動装置の振動体のセンサ電極部を示す図。

【図３】圧電効果を示す説明図。

【図４】図１の振動装置の振動体の側面図。

【図５】図１の振動装置の振動体に印加される交番電圧波形を示す図。

【図６】図１の振動装置の振動体の挙動を示す図。

【図７】図１の振動装置の振動体のセンサ電極部の出力電圧波形と、横（屈曲）振動と縦振動を表す電圧波形を示す図。

【図８】横（屈曲）振動と縦振動を表す電圧波形を合成した図。

【図９】楕円軌道の形状と波頭の接線速度を示す図。

【図１０】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１１】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１２】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１３】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１４】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１５】印加電圧の位相差および振幅比を変化させたときのセンサ電極部の出力電圧波形と、横振動・縦振動の様子を示す図。

【図１６】本実施の形態の振動装置の制御回路を示す図。

【図１７】図１６の振動装置の制御回路の一部を示す回路図。

【図１８】図１６の振動装置の制御回路の一部を示す回路図とタイムチャート。

【図１９】図１６の振動装置の制御回路の一部を示す回路図。

【符号の説明】

１　振動体

２ａ，２ｂ　駆動子

４　接触体としてのガイドレール

１ｅ～１ｈ　電気－機械エネルギー変換の為の信号入力部としての電極部

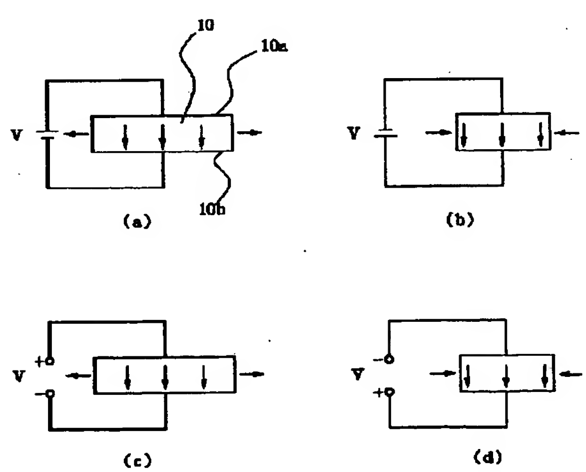
１ｇ－１，１ｈ－１　機械－電気エネルギー変換の為の信号入力部としてのセンサ電極部

V_A, V_B　印加交番電圧

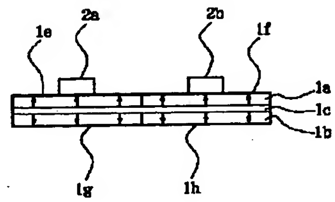
S_A, S_B　センサ電極部出力電圧

２６　マイクロコンピュータ

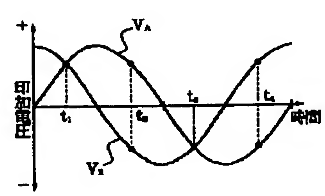
【図３】



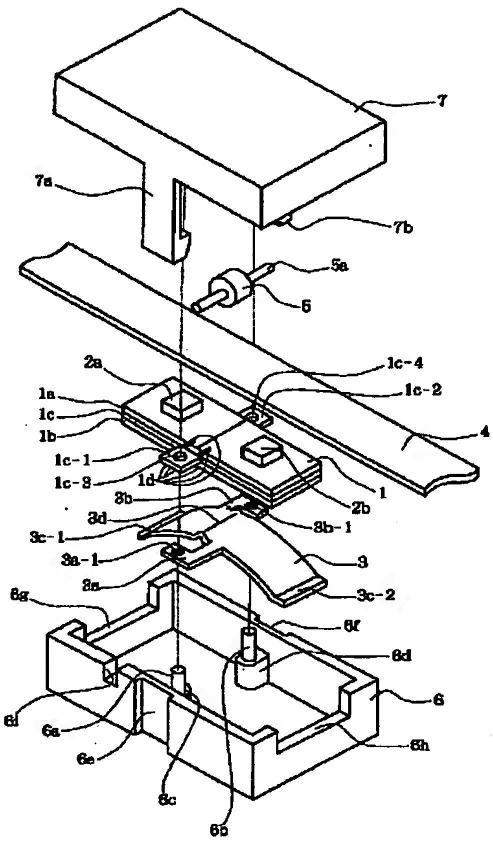
【図４】



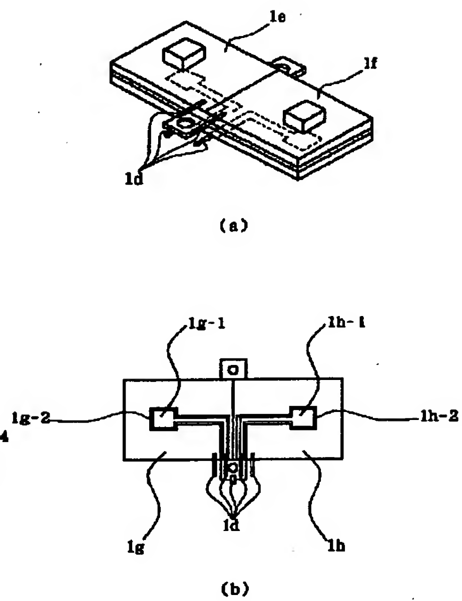
【図５】



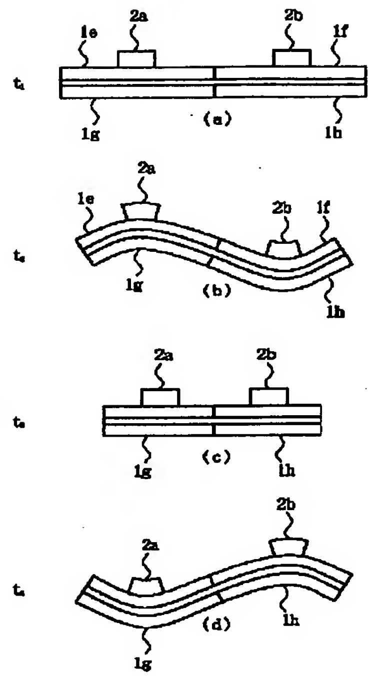
【図1】



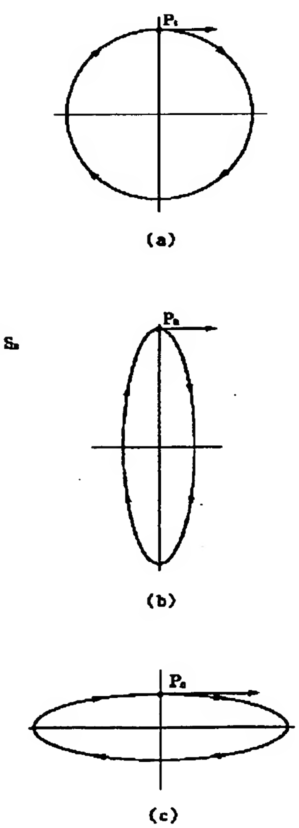
【図2】



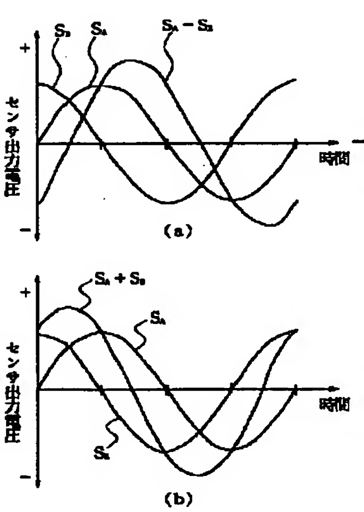
【図6】



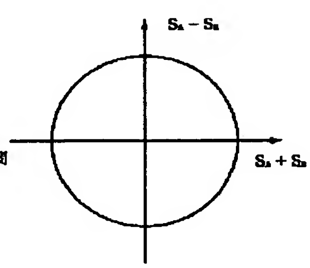
【図9】



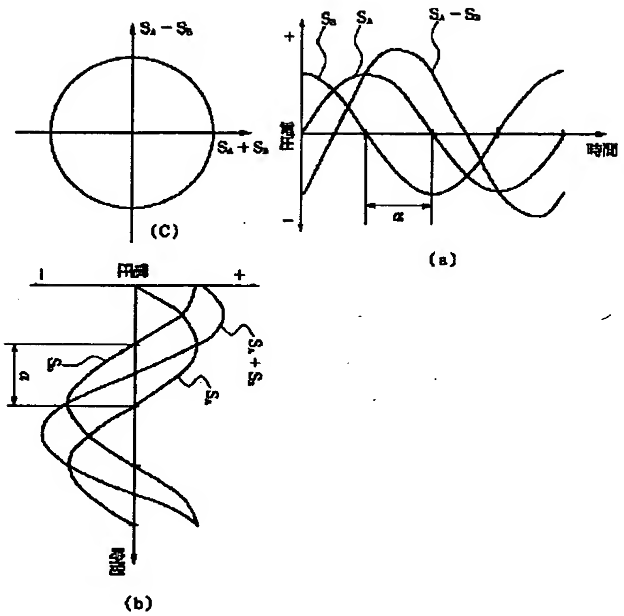
【図7】



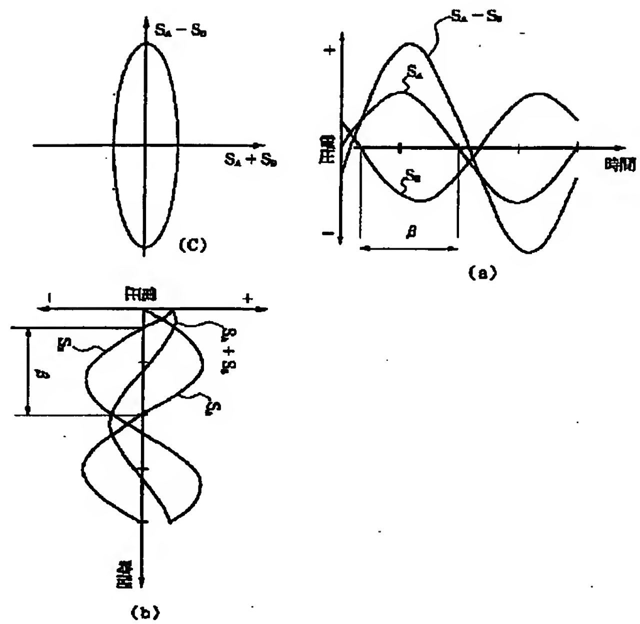
【図8】



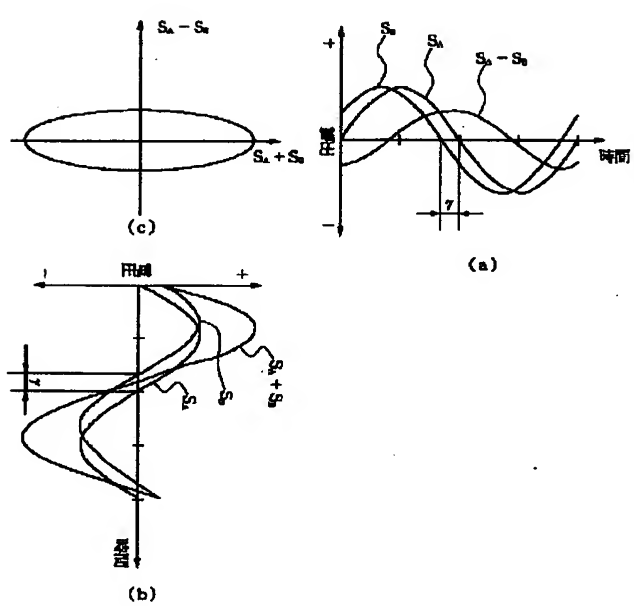
【図１０】



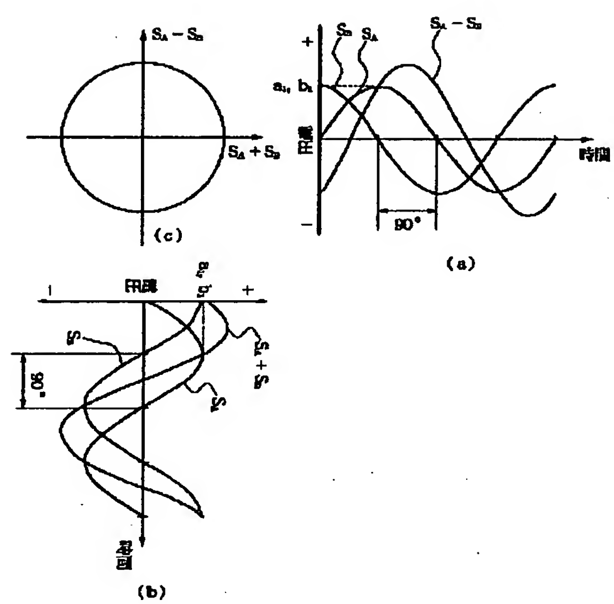
【図１１】



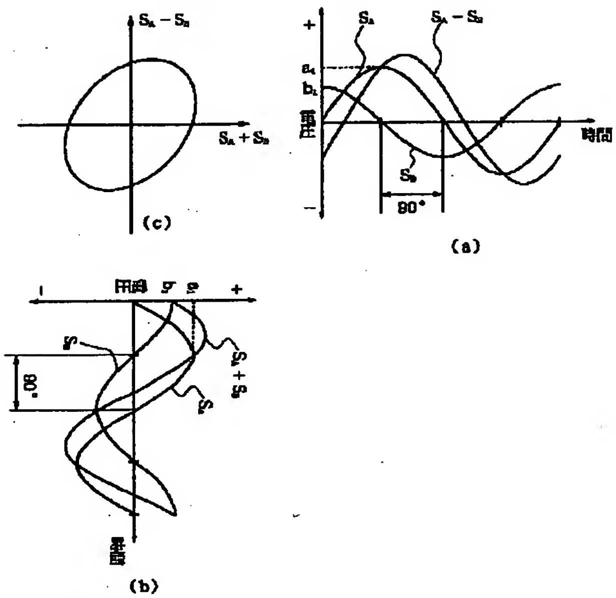
【図１２】



【図１３】

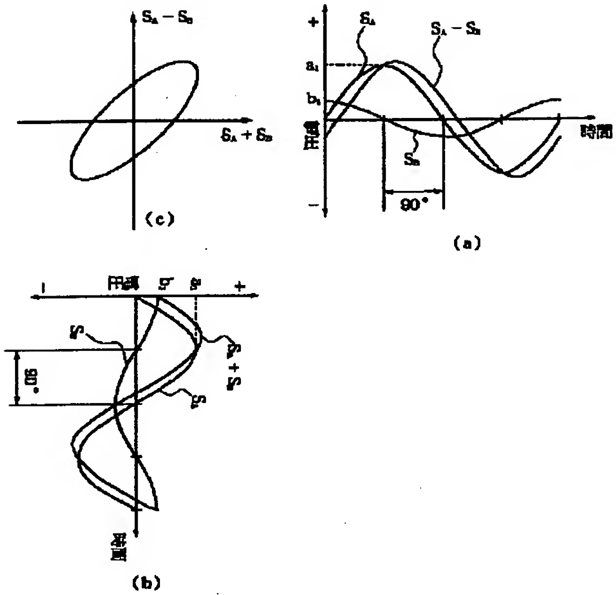


【図14】



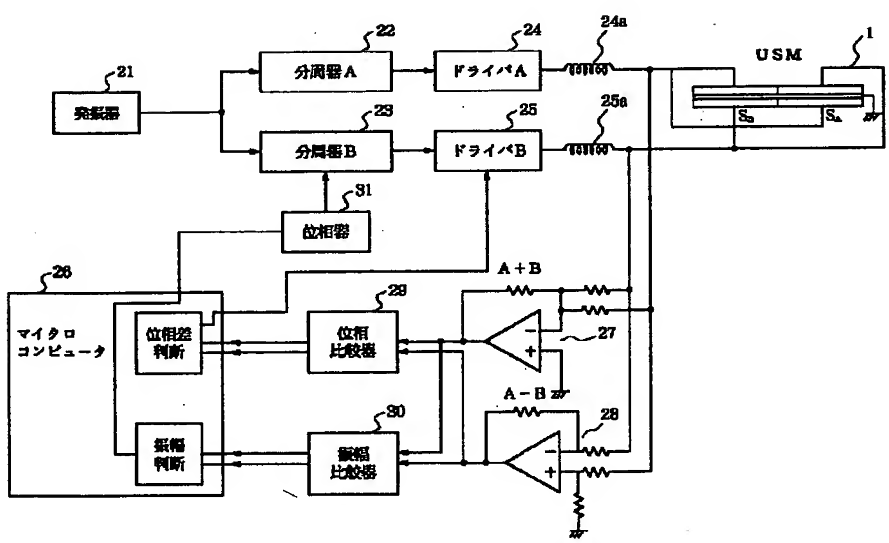
S_A-S_B
S_A+S_B
(c)
S_A
S_A-S_B
a_1
b_1
振幅
時間
S_B
90°
(a)
振幅
S_A+S_B
S_A
S_B
90°
時間
(b)

【図15】



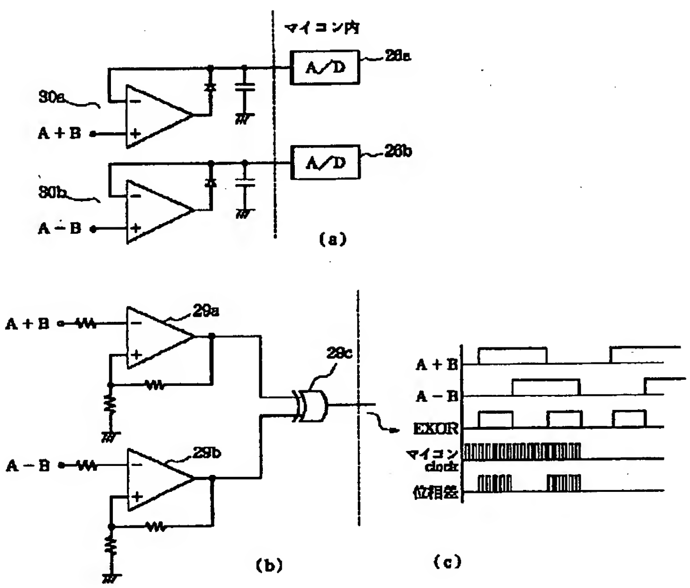
S_A-S_B
S_A+S_B
(c)
S_A
S_A-S_B
a_1
b_1
振幅
時間
S_B
90°
(a)
振幅
S_A+S_B
S_A
S_B
90°
時間
(b)

【図16】

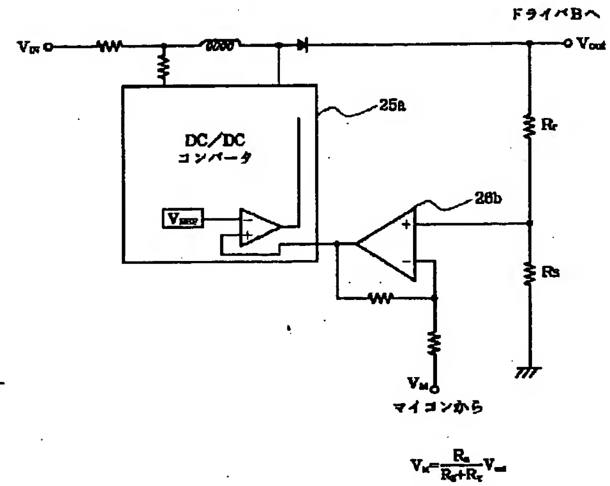


21
発振器
22
分周器A
23
分周器B
24
ドライバA
25
ドライバB
24a
25a
1
USM
S_B
S_A
31
位相器
26
マイクロコンピュータ
位相差判断
振幅判断
29
位相比較器
30
振幅比較器
A＋B
27
A－B
28

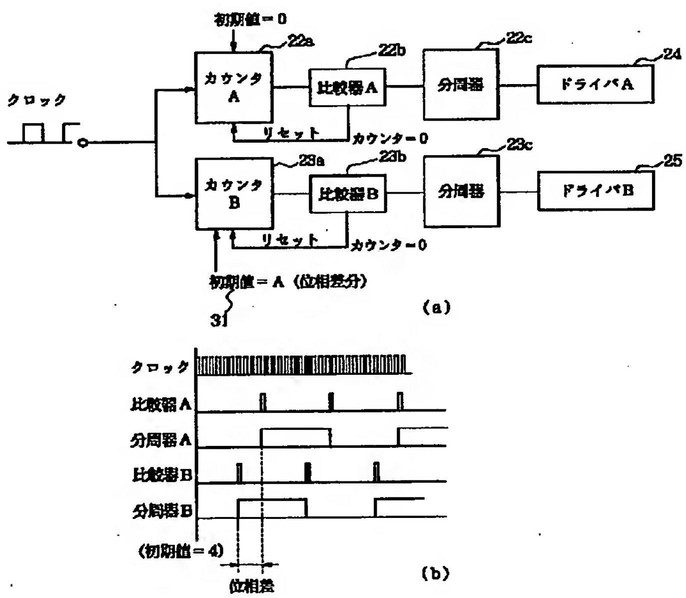
【図17】


マイコン内
A/D
28a
30a
A+B
A/D
28b
30b
A−B
(a)
A+B
29a
29c
A−B
29b
(b)
A+B
A−B
EXOR
マイコン clock
位相差
(c)

【図19】


ドライバBへ
V_{IN}
V_{out}
25a
DC/DC
コンバータ
V_{REF}
26b
R_f
R_s
V_M
マイコンから
$V_M=\frac{R_s}{R_s+R_f}V_{out}$

【図18】


初期値=0
22a
22b
22c
24
クロック
カウンタ A
比較器A
分周器
ドライバA
リセット
カウンタ=0
23a
23b
23c
25
カウンタ B
比較器B
分周器
ドライバB
リセット
カウンタ=0
初期値=A（位相差分）
31
(a)
クロック
比較器A
分周器A
比較器B
分周器B
（初期値=4）
位相差
(b)

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-233869
(43)Date of publication of application : 05.09.1997

(51)Int.Cl. H02N 2/00
B06B 1/06

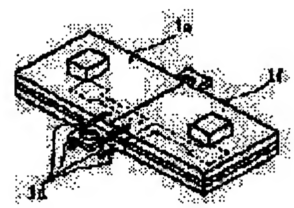
(21)Application number : 08-036528
(22)Date of filing : 23.02.1996

(71)Applicant : CANON INC
(72)Inventor : AKATA KOJI
SUGIMORI MASAMI

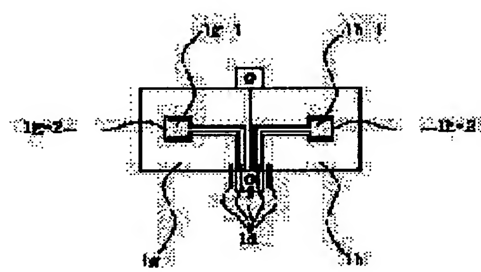
(54) VIBRATING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To detect the behavior of the elliptic motion of a vibrating body accurately and to obtains the excellent driving performance by detecting the amplitudes of the bending vibration and the vertical vibration of the vibrating body formed by forming a stack of an electromechanical energy converting element ands an elastic body.

SOLUTION: At electrode parts 1g and 1h of an electrode layer provided at both surface of a vibrating body, sensor electrode parts 1h-1 and 1h-1, which becomes the signal output parts for mechanical-electrical energy conversion, and insulating parts 1g-2 and 1h-2 are formed. The sensor electrode parts 1g-1 and 1h-1 and the electrode parts 1g and 1h are not conducted, respectively. When alternating voltages are applied to the electrode parts 1e and 1f and the electrode parts 1f and 1g, the output voltages of the sensor electrode parts 1h-1 and and the sensor electrode 1g-1 and the amplitudes of the bending vibration and the vertical vibration are detected. Thus, the behavior of the elliptic motion of the vibrating body can be accurately detected, and the excellent driving performance can be obtained.



(a)



(b)

LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Laid-open Patent Application No. 09-233869

Japan Patent Office provides this translation by using a computer.

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The alternation signal with which phases differ is supplied to the oscillating object which comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, and two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object Rocking equipment characterized by establishing a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation.

[Claim 2] The alternation signal with which phases differ is supplied to the oscillating object which comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, and two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object Rocking equipment characterized by establishing a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the balance of the supply signal intensity to two or more signal input parts of said sensing element based on the output of said detection means.

[Claim 3] The alternation signal with which phases differ is supplied to the oscillating object which comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, and two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object Rocking equipment characterized by establishing a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the phase of the supply signal to two or more signal input parts of said sensing element based on the output of said detection means.

[Claim 4] It is rocking equipment according to claim 1, 2, or 3 characterized by having arranged said sensing element, having stationed said two or more signal output parts for machine-electrical energy conversion in the location of two or more of said knots, and detecting the amplitude of said crookedness vibration and longitudinal oscillation based on the output from said signal output part so that the location used as the knot of said crookedness vibration can do two or more places of said oscillating object.

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the rocking equipment using vibration.
[0002]
[Description of the Prior Art] Conventionally, as this kind of a motor, there were some which are indicated by JP,61-251490,A, JP,61-35176,A, and JP,6-133568,A, for example. According to these official reports, it was equipment which is going to acquire a stable drive property by detecting the amplitude of an elastic body by preparing sensor equality by the progressive wave type ultrasonic motor, changing an input frequency or controlling input voltage.
[0003]
[Problem(s) to be Solved by the Invention] However, the configuration of an ellipse is undetectable even if the amplitude of ellipse movement to which the oscillating object is actually carrying out these equipments is detectable. For example, if it carries out adjustable [of the frequency], it cannot judge whether the configuration of an ellipse changed whether the amplitude of an ellipse became small. Moreover, although changing an input frequency is performed in order to control the rate of an ultrasonic motor, depending on a frequency, it accelerates suddenly, or the unstable element of stopping is also considered.
[0004] Moreover, also in the ultrasonic motor of a standing wave mold, it is difficult to control the speed in the stable drive property by having detected only the amplitude of vibration of the vibrator displaced in the vertical direction.
[0005]
[Means for Solving the Problem] The oscillating object with which invention of claim 1 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation.
[0006] The oscillating object with which invention of claim 2 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the balance of the supply signal intensity to two or more signal input parts of said sensing element based on the output of said detection means.
[0007] The oscillating object with which invention of claim 3 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the phase of the supply signal to two or more signal input parts of said sensing element based on the output of said detection means.

[0008] Said sensing element is arranged and two or more signal output parts for machine-electrical energy conversion are stationed in the location of two or more of said knots so that two or more invention of claim 4 may be made as for the location used as the knot of said crookedness vibration to said oscillating object, and it is characterized by the rocking equipment which detected the amplitude of said crookedness vibration and longitudinal oscillation based on the output from said signal output part.
[0009]
[Embodiment of the Invention]
(Example) In drawing 1 , 1 is an oscillating object and pressurization adhesion of the piezoelectric devices 1a and 1b as a tabular energy conversion component of a pair is carried out at both the principal planes of elastic body 1c formed in tabular with phosphor bronze, brass, etc. Moreover, electrical conducting materials, such as nickel and copper, are vapor-deposited by both the principal planes of the oscillating object 1, and the electrode layer is formed. The electrode layer consists of four polar zone 1e-1h which carries out insulating division, is formed in the location which carries out the longitudinal direction of the oscillating object 1 for 2 minutes, and turns into a signal input part for electric - evaporation energy conversion. Furthermore, as drawing 2 shows, sensor polar-zone 1g-1 which becomes a signal output part for machine-electrical energy conversion, 1h-1 and insulating section 1g-2, and 1h-2 are formed, and sensor polar-zone 1g-1, 1h-1, and polar zone 1g and 1h are un-flowing at polar zone 1g and 1h, respectively. Moreover, the location of the principal part of sensor polar-zone 1g-1 and 1h-1 is formed in the back side of the below-mentioned drive child's pasting location. Moreover, sensor polar-zone 1g-1 and 1h-1 are drawn near the **** of the oscillation mode of the oscillating object 1 (near the longitudinal direction center of the oscillating object 1) from a part of principal part. It ******s to elastic body 1c, there are section 1c-1 and 1c-2, and engagement hole 1c-3 and 1c-4 are prepared in the center section of this overhang section. The location of the overhang section has become near the **** of the oscillation mode of the oscillating object 1, and has avoided the bad influence to the oscillation mode. Furthermore, 1d of a total of seven terminal areas is attached in polar-zonee [1]-1h and sensor electrode 1g-1, 1h-1, and elastic body 1c by soldering etc. Those locations have become near the **** for the same reason as the above-mentioned.
[0010] 2a and 2d, it is one pair of drive children formed with phenol resin, an epoxy resin, etc., and in order to obtain higher driving force, it is attached in the location of the abdomen of the oscillation mode of an oscillating object by adhesion etc.
[0011] 3 is the pressurization spring formed by phosphor bronze etc., the overhang sections 3a and 3b are formed, and engagement hole 3a-1 and 3b-1 are prepared in the overhang section, respectively. Moreover, it bends in the longitudinal direction both ends of the pressurization spring 3, and section 3c-1 and 3c-2 are prepared. Furthermore, 3d of heights is formed crosswise in the center section of the pressurization spring 3.
[0012] 4 is a guide rail as a contact object formed with stainless steel etc.
[0013] 5 is a roller and bearing-bar 5a which supports a roller is attached by the approach of common knowledge, such as press fit.
[0014] 6 is the case by which plastics mold processing was carried out, the engagement shanks 6a and 6b are formed, and Stoppers 6c and 6d are formed in those roots. Moreover, the slots 6g and 6h with a little larger width of face than a guide rail 4 are established in the longitudinal direction both-ends upper part of a case 6. Moreover, slot 6i is prepared in some cases 6. Furthermore, Slots 6e and 6f are established in the crosswise both ends of a case 6.
[0015] 7 is the cap by which plastics mold processing was carried out, and the hole (un-illustrating) in which the bearing slot (un-illustrating) which supports bearing-bar 5a to revolve, and the engagement shanks 6a and 6b are inserted is prepared. Furthermore, the pieces 7a and 7b of pinching with a stop pawl are formed in the crosswise both ends of cap 7.
[0016] Next, the interrelation of each part article is explained.
[0017] engagement hole 3a-1 prepared in the engagement shanks 6a and 6b prepared in the case 6 at the pressurization spring 3, respectively -- 3b-1 engagement (insertion) is carried out. The overhang sections 3a and 3b of the pressurization spring 3 are then bent a little by engagement shaft orientations, and the engagement shanks 6a and 6b and the fitting backlash of

engagement hole 3a-1 and 3b-1 are lost. And the pressurization spring 6 is slid and stops until bending section 3c-1 and 3c-2 contact the base of a case. The amount of the maximum deflections of the pressurization spring 6 bends until the overhang sections 3a and 3b run against the stoppers 6c and 6d of a case 6.
[0018] The engagement shanks 6a and 6b of a case 6 are inserted in engagement hole 1c-3 prepared in elastic body 1c of the oscillating object 1 next, and 1c-4, respectively. Overhang section 1c-1 is then bent a little by engagement shaft orientations, and the engagement shafts 6a and 6b and the fitting backlash of engagement hole 1c-3 and 1c-4 are lost. And the oscillating object 1 is slid until it contacts piezoelectric-device 1b of the oscillating object 1 at 3d of heights of the pressurization spring 3.
[0019] Wearing immobilization of the both ends of bearing-bar 5a attached in the roller 5 by approaches, such as press fit, is carried out at bearing (un-illustrating) prepared in the cap 7.
[0020] On both sides of a guide rail 4, as the pressurization spring 3, the case 6 where the oscillating object 1 was attached, and the case 7 where the roller 5 was attached are crowded with the field of a roller 5, and the field of drive child 2a and 2b, they are attached in them. In that case, the pieces 7a and 7b of pinching which have the stop pawl formed in the cap 7 are guided to the slots 6e and 6f of a case 6, and are attached by the snap fitting. Moreover, then, it engages with the engagement shafts 6a and 6b of a case 6, and the hole (un-illustrating) prepared in the cap 7, and cap 7 is positioned with a case 6. Furthermore, as for a guide rail 4, migration crosswise is regulated by the slots 6g and 6h of a case 6.
[0021] 1d of polar-zonee [1]-1h and 1g [of sensor polar zone] - 1 or 1h - terminal areas prepared in 1 and elastic body 1c is soldered to lead wire or a flexible printed circuit board, they are pulled out in the exterior of a case 6 from slot 6i by which lead wire or a flexible printed circuit board was prepared in the case 6, and electric supply and sensing of them become possible by connecting lead wire or a flexible printed circuit board in an external drive circuit.
[0022] The drive principle of the rocking equipment of the gestalt of this operation is explained.
[0023] Drawing 3 is drawing having shown the piezo-electric effect of a piezoelectric device. In this drawing, 10 is a piezoelectric device and polarization processing is made from the upper part of drawing in the lower part (the direction of the drawing Nakaya mark). Moreover, polar zone 10a and 10b is given to both sides of a piezoelectric device by vacuum evaporationo processing.
[0024] Drawing 3 (a) is drawing having shown the situation when impressing - potential to polar-zone 10a at + potential and polar-zone 10b. In this case, since electric field are impressed to the direction of polarization, i.e., the direction, and the forward direction of polar-zone 10a to polar-zone 10b, the amount of elongation according to the magnitude of elongation and electric field generates a piezoelectric device in the perpendicular direction to the direction of polarization at a piezoelectric device.
[0025] Drawing 3 (b) is drawing having shown the situation when impressing + potential to polar-zone 10a at - potential and polar-zone 10b. In this case, in a piezoelectric device, since electric field are impressed to the direction of polarization, i.e., the direction, and hard flow of polar-zone 10b to polar-zone 10a, a piezoelectric device is shrunken in the perpendicular direction to the direction of polarization, and the amount of shrinkage according to the magnitude of electric field occurs.
[0026] Drawing 3 (c) is drawing having shown the situation when perpendicularly lengthening a piezoelectric device according to external force to the direction of polarization. In this case, - potential arises in polar-zone 10a at + potential and polar-zone 10b, and the potential difference according to the amount of elongation occurs.
[0027] Drawing 3 (d) is drawing having shown the situation when perpendicularly drawing in one's piezoelectric device according to external force to the direction of polarization. In this case, + potential arises in polar-zone 10a at - potential and polar-zone 10b, and the potential difference according to the amount of shrinkage occurs.
[0028] The oscillating object of the rocking equipment of the gestalt of this operation tends to excite a standing wave so that ellipse movement may occur to a drive child using these piezoelectric phenomena.
[0029] Drawing 4 is the side elevation of the oscillating object of rocking equipment. As for

piezoelectric-device 1a, polarization processing is performed upwards from the lower part of drawing, and, as for piezoelectric-device 1b, polarization processing is performed to the lower part from the upper part of drawing. Moreover, elastic body 1c is connected to the ground. Thus, if the alternation electrical potential difference VA of in phase and this amplitude is impressed to polar zone 1e and 1h as shown in drawing 5 , and the alternation electrical potential difference VB of in phase and this amplitude is impressed to the constituted oscillating object 1 at polar zone 1f and 1g (however, polar zone [1e and 1h] alternation electrical potential differences differ in a phase), an oscillating object will develop various behavior according to the piezo-electric effect. For example, the behavior of the piezoelectric transducer in the time amount t1 of drawing 5 is equivalent to polar zone 1e-1h, and since the electrical potential difference of + is impressed, as drawing 6 (c) shows, shrinkage arises. Since the electrical potential difference of + is impressed to polar zone 1e and 1h and the electrical potential difference of the equivalent is impressed to polar zone 1f and 1g for polar zone [1e and 1h] applied voltage and an absolute value on the electrical potential difference of -, the behavior of the piezoelectric transducer in the time amount t2 of drawing 5 is crooked as drawing 6 (d) shows.

[0030] The behavior of the piezoelectric transducer in the time amount t3 of drawing 5 is equivalent to polar zone 1e-1h, and since the electrical potential difference of - is impressed, as drawing 6 (a) shows, elongation arises. Since the electrical potential difference of - is impressed to polar zone 1e and 1h and the electrical potential difference of the equivalent is impressed to polar zone 1f and 1g for polar zone [1e and 1h] applied voltage and an absolute value on the electrical potential difference of +, the behavior of the oscillating object in the time amount t4 of drawing 5 is crooked as drawing 6 (b) shows.

[0031] When behavior is seen by continuous time amount from the above thing, an oscillating object will show the behavior by which flexible movement (longitudinal oscillation) and a curvature movement (transverse oscillation) were compounded, and drive child 2a and 2b will draw an elliptical orbit. And the hand of cut of the elliptical orbit of drive child 2a and 2b is in agreement. Moreover, if the phase of the alternation electrical potential differences VA and VB is reversed, the hand of cut of an elliptical orbit will turn into the above-mentioned direction and hard flow.

[0032] If slide members, such as a guide rail, are pressed to drive child 2a which performs ellipse movement as mentioned above, and 2b, driving force will occur and a slide member and drive children, such as a guide rail, will become movable relatively. If a guide rail is fixed, though natural, an oscillating object will move. Moreover, the reverse can also be carried out.

[0033] The detection approach of of the transverse oscillation and longitudinal oscillation of the rocking equipment of this invention is explained.

[0034] When the piezoelectric device deformed according to the piezo-electric effect, it mentioned above that the piezo-electricity according to the deformation occurred. Then, the sensor polar zone which can supervise the deformation of a piezoelectric device apart from the electrode for a drive on the oscillating object of rocking equipment was prepared, and how to detect transverse oscillation and longitudinal oscillation was considered. The magnitude in the time amount of the arbitration of transverse oscillation (crookedness vibration) is decided by the amount of elongation of the piezoelectric device by polar zone [in the time amount of arbitration / 1e and 1h] applied voltage (or the amount of shrinkage), and the amount of contractions of the piezoelectric device by polar zone [1f and 1g] applied voltage (or the amount of elongation). That is, it can express with the difference of the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor electrode 1g-1.

[0035] Moreover, the magnitude in the time amount of the arbitration of longitudinal oscillation is decided by the amount of elongation of the piezoelectric device by polar zone [in the time amount of arbitration / 1e and 1h] applied voltage (or the amount of shrinkage), and the amount of contractions of the piezoelectric device by polar zone [1f and 1g] applied voltage (or the amount of elongation). That is, it can express by the sum of the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor electrode 1g-1.

[0036] Drawing 7 shows the voltage waveform of SA+SB showing SA-SB showing the output voltage SB of sensor polar-zone 1g-1 when impressing the alternation electrical potential

difference VA shown in drawing 5 to the polar zone 1e and 1h of the oscillating object 1, and impressing the alternation electrical potential difference VB shown in drawing 5 to polar zone 1f and 1g, the output voltage SA of sensor polar-zone 1g-1, and transverse oscillation, and longitudinal oscillation.

[0037] If an axis of abscissa is met in SA+SB, time amount is met for an axis of ordinate in SA-SB and a curve is made to draw, it will become like drawing 8 . This curve is right and expresses a drive child's elliptical orbit.

[0038] As mentioned above, it turns out that the behavior of transverse oscillation and longitudinal oscillation is known and a drive child's elliptical orbit can be expressed by detecting the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor polar-zone 1g-1.

[0039] By the way, the tangential velocity of the wave front of ellipse movement changes with configurations of an elliptical orbit. For example, to P1 point [of the elliptical orbit of drawing 9 (a)] tangential velocity, P2 point [of the elliptical orbit of drawing 9 (b)] tangential velocity becomes slow, and P3 point [of the elliptical orbit of drawing 9 (c)] tangential velocity becomes quick. Therefore, supposing the elliptical orbit of drawing 9 is a motion of a drive child, by changing the configuration of an elliptical orbit, I hear that relative velocity with slide members, such as a guide rail, can be changed, and it is.

[0040] Then, polar zone It considered changing the configuration of a drive child's elliptical orbit and changing relative velocity with a slide member by changing the phase contrast and the gain of the impression alternation electrical potential difference (1e and 1h) VA and the polar zone [1f and 1g] impression alternation electrical potential difference VB.

[0041] First, the amplitude of VA and VB is made regularity (the amplitude of SA and SB is also theoretically fixed), and if the elliptical orbit when changing phase contrast is made to draw, it will become like drawing 10 -12.

[0042] the phase contrast of VA and VB in drawing 10 -- alpha (the phase contrast of SA and SB ** -- theoretic -- alpha --) the phase contrast of VA and VB in 0 degree < alpha< 180 degrees and drawing 11 -- beta (the phase contrast of SA and SB -- theoretic -- beta --) If phase contrast of VA and VB in 0 degree < beta< 180 degrees and drawing 12 is set to gamma (the phase contrast of SA and SB is also gamma and 0 degree < gamma< 180 degrees theoretically), the configuration of an elliptical orbit will become longwise by considering as beta>alpha compared with the time of phase contrast alpha. Moreover, the configuration of an elliptical orbit becomes longwise by considering as gamma<alpha compared with the time of phase contrast alpha.

[0043] If the amplitude of VA and VB is fixed and phase contrast is changed from the above thing, the configuration of an elliptical orbit will change and the tangential velocity of the wave front of an elliptical orbit will change. That is, the tangential velocity of a drive child's elliptical orbit can be changed, and relative velocity with slide members, such as a guide rail, can be changed to arbitration.

[0044] If the phase contrast of VA and VB is set as 90 degrees and the gain of VA and VB is changed next, it will become like drawing 13 , drawing 14 , and drawing 15 .

[0045] The amplitude of the output voltage SA and SB of the sensor polar zone according to the amplitude of an impression alternation electrical potential difference is set to a3 and b3 in a2, b2, and drawing 15 in a1, b1, and drawing 14 in drawing 13 , respectively.

[0046] | If the amplitude of an impression alternation electrical potential difference is adjusted so that it may become a1 | = | a2 | = | a3 | = | b1 | > | b2 | > | b3 |, and each elliptical orbit is compared, compared with the time of b1, the configuration of the elliptical orbit at the time of b2 will become a little long and slender. Moreover, in the case of b3, it becomes a still more long and slender configuration.

[0047] If the phase contrast of VA and VB is set as 90 degrees and the gain of VA and VB is changed from the above thing, the configuration of an elliptical orbit will change and the tangential velocity of the wave front of an elliptical orbit will change. That is, the tangential velocity of a drive child's elliptical orbit can be changed, and relative velocity with slide members, such as a guide rail, can be changed to arbitration.

[0048] Next, the configuration about control is shown.

[0049] Drawing 16 is the circuit block diagram showing the gestalt of operation of this invention.
[0050] Dividing of the high frequency signal higher than the drive frequency outputted from the oscillator 21 is carried out to a predetermined frequency, it is changed into counting-down circuits 22 and 23 at drive frequency, and is outputted to a driver A24 and a driver B25. Drivers A24 and B25 amplify the signal acquired from the counting-down circuit, and impress it to an ultrasonic motor 1 (as specifically mentioned above, impressed to the polar zone of a piezoelectric device). Moreover, when a signal is impressed to an ultrasonic motor, it will resonate between coil 24a, coil 25b, and a piezoelectric device, and an electrical potential difference higher than the electrical potential difference inputted into drivers A24 and B25 will be impressed to a piezoelectric device. The output voltage from the sensor polar zone according to the behavior of the piezoelectric device at this time is detected, an adder circuit 27 performs A+B, longitudinal oscillation is detected, a subtractor circuit 28 performs A-B, and crookedness (width) vibration is detected. The longitudinal oscillation and crookedness (width) vibration which were detected output the result which it was sent to the phase comparator 29 and the magnitude-comparison machine 30, and was compared, respectively to a microcomputer 26. A microcomputer 26 judges the behavior of an ellipse from the inputted phase contrast and an amplitude difference, and it outputs a signal so that the behavior of an ellipse may be adjusted to a phase shifter 31 and a driver B25, respectively.
[0051] For example, the magnitude-comparison machine 30 carries out half-wave rectification of the signal of A+B and A-B shown with a sine wave function like drawing 17 (a), respectively, it is changed into a dc component, is changed into amplitude value, and compares by performing A/D conversion with a microcomputer 26.
[0052] Then, the phase contrast of input signals A and B is changed with a phase shifter 31 from the obtained gain. For example, before inputting the clock from an oscillator 21 into counter A22a and counter B23a like drawing 18 , the initial value in the direction of counter B23a is set up, and phase contrast with counter A22a is set up. Then, if a clock is inputted into Counters A and B and it is in agreement as compared with a predetermined compound value, Counters A and B will be cleared. A phase will shift to a part for initial value, and a usual state by this. Dividing of the signal acquired from Comparator A,. B-22b, and 23b is carried out with counting-down circuits 22c and 23c, and it changes into the square wave of 50% of duty ratio, and outputs to a driver A24 and a driver B25. The phase contrast of a driving signal can be changed into arbitration by this.
[0053] Moreover, a phase comparator 29 changes A+B and A-B into a square wave with a hysteresis comparator like drawing 17 (b) as compared with a reference value. The signal with which only the time amount for through phase contrast turns on EXOR29c for the changed square wave can be made, and phase contrast can be judged with the number of the reference clocks in the microcomputer within the time amount.
[0054] Moreover, from the acquired phase contrast, a microcomputer 26 changes the electrical potential difference impressed to a driver B25, and adjusts the behavior of an ellipse. For example, DC to DC converter 25a has determined the power source of Driver B. In this case, in order to control the electrical potential difference which a DC to DC converter outputs, the electrical potential difference outputted by comparator 26b of drawing 19 is controllable by the electrical potential difference which a microcomputer outputs.
[0055] By the above-mentioned explanation, it becomes possible to actually adjust the behavior (locus) of an ellipse, and it is stabilized and speed control of an ultrasonic motor can be performed.
[0056]
[Effect of the Invention] According to invention of claim 1, the behavior of ellipse movement of an oscillating object can be detected correctly, and control for obtaining the good drive engine performance can be enabled.
[0057] According to invention of claim 2, the behavior of ellipse movement of an oscillating object can be detected correctly, and speed control becomes possible by changing the form of the elliptical orbit of ellipse movement by the detection result further.
[0058] According to invention of claim 3, the behavior of ellipse movement of an oscillating object

can be detected correctly, and speed control becomes possible by changing the form of the elliptical orbit of ellipse movement by the detection result further.
[0059] According to invention of claim 4, crookedness vibration of an oscillating object and longitudinal oscillation are correctly detectable.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the rocking equipment using vibration.

PRIOR ART

[Description of the Prior Art] Conventionally, as this kind of a motor, there were some which are indicated by JP,61-251490,A, JP,61-35176,A, and JP,6-133568,A, for example. According to these official reports, it was equipment which is going to acquire a stable drive property by detecting the amplitude of an elastic body by preparing sensor equality by the progressive wave type ultrasonic motor, changing an input frequency or controlling input voltage.

EFFECT OF THE INVENTION

[Effect of the Invention] According to invention of claim 1, the behavior of ellipse movement of an oscillating object can be detected correctly, and control for obtaining the good drive engine performance can be enabled.
[0057] According to invention of claim 2, the behavior of ellipse movement of an oscillating object can be detected correctly, and speed control becomes possible by changing the form of the elliptical orbit of ellipse movement by the detection result further.
[0058] According to invention of claim 3, the behavior of ellipse movement of an oscillating object can be detected correctly, and speed control becomes possible by changing the form of the elliptical orbit of ellipse movement by the detection result further.
[0059] According to invention of claim 4, crookedness vibration of an oscillating object and longitudinal oscillation are correctly detectable.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, the configuration of an ellipse is undetectable even if the amplitude of ellipse movement to which the oscillating object is actually carrying out these equipments is detectable. For example, if it carries out adjustable [of the frequency], it cannot judge whether the configuration of an ellipse changed whether the amplitude of an ellipse became small. Moreover, although changing an input frequency is performed in order to control the rate of an ultrasonic motor, depending on a frequency, it accelerates suddenly, or the unstable element of stopping is also considered.
[0004] Moreover, also in the ultrasonic motor of a standing wave mold, it is difficult to control the speed in the stable drive property by having detected only the amplitude of vibration of the vibrator displaced in the vertical direction.

MEANS

[Means for Solving the Problem] The oscillating object with which invention of claim 1 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized

by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation.

[0006] The oscillating object with which invention of claim 2 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the balance of the supply signal intensity to two or more signal input parts of said sensing element based on the output of said detection means.

[0007] The oscillating object with which invention of claim 3 comes to carry out the laminating of the elastic body to electric-mechanical energy sensing element, The alternation signal with which phases differ is supplied to two or more signal input parts of said sensing element. In the rocking equipment which is made to carry out longitudinal oscillation of said oscillating object to crookedness vibration, is made to carry out ellipse movement of the operation section by composition of both vibration, and enables relative displacement of the contact object in contact with said oscillating object, and said oscillating object It is characterized by the rocking equipment which established a detection means to detect the amplitude of said crookedness vibration of said oscillating object and said longitudinal oscillation, and the control means which changes the phase of the supply signal to two or more signal input parts of said sensing element based on the output of said detection means.

[0008] Said sensing element is arranged and two or more signal output parts for machine-electrical energy conversion are stationed in the location of two or more of said knots so that two or more invention of claim 4 may be made as for the location used as the knot of said crookedness vibration to said oscillating object, and it is characterized by the rocking equipment which detected the amplitude of said crookedness vibration and longitudinal oscillation based on the output from said signal output part.

[0009]

[Embodiment of the Invention]

EXAMPLE

(Example) In drawing 1 , 1 is an oscillating object and pressurization adhesion of the piezoelectric devices 1a and 1b as a tabular energy conversion component of a pair is carried out at both the principal planes of elastic body 1c formed in tabular with phosphor bronze, brass, etc. Moreover, electrical conducting materials, such as nickel and copper, are vapor-deposited by both the principal planes of the oscillating object 1, and the electrode layer is formed. The electrode layer consists of four polar zone 1e-1h which carries out insulating division, is formed in the location which carries out the longitudinal direction of the oscillating object 1 for 2 minutes, and turns into a signal input part for electric - evaporation energy conversion. Furthermore, as drawing 2 shows, sensor polar-zone 1g-1 which becomes a signal output part for machine-electrical energy conversion, 1h-1 and insulating section 1g-2, and 1h-2 are formed, and sensor polar-zone 1g-1, 1h-1, and polar zone 1g and 1h are un-flowing at polar zone 1g and 1h, respectively. Moreover, the location of the principal part of sensor polar-zone 1g-1 and 1h-1 is formed in the back side of the below-mentioned drive child's pasting location. Moreover, sensor polar-zone 1g-1 and 1h-1 are drawn near the **** of the oscillation mode of the oscillating object 1 (near the longitudinal direction center of the oscillating object 1) from a part of principal part. It ******s to elastic body 1c, there are section 1c-1 and 1c-2, and engagement hole 1c-3 and 1c-4 are prepared in the center section of this overhang section. The location of the overhang section has become near the **** of the oscillation mode of the oscillating object 1, and has avoided the bad influence to the oscillation mode. Furthermore, 1d of a total of seven terminal areas is

attached in polar-zonee [1]-1h and sensor electrode 1g-1, 1h-1, and elastic body 1c by soldering etc. Those locations have become near the **** for the same reason as the above-mentioned.
[0010] 2a and 2d, it is one pair of drive children formed with phenol resin, an epoxy resin, etc., and in order to obtain higher driving force, it is attached in the location of the abdomen of the oscillation mode of an oscillating object by adhesion etc.
[0011] 3 is the pressurization spring formed by phosphor bronze etc., the overhang sections 3a and 3b are formed, and engagement hole 3a-1 and 3b-1 are prepared in the overhang section, respectively. Moreover, it bends in the longitudinal direction both ends of the pressurization spring 3, and section 3c-1 and 3c-2 are prepared. Furthermore, 3d of heights is formed crosswise in the center section of the pressurization spring 3.
[0012] 4 is a guide rail as a contact object formed with stainless steel etc.
[0013] 5 is a roller and bearing-bar 5a which supports a roller is attached by the approach of common knowledge, such as press fit.
[0014] 6 is the case by which plastics mold processing was carried out, the engagement shanks 6a and 6b are formed, and Stoppers 6c and 6d are formed in those roots. Moreover, the slots 6g and 6h with a little larger width of face than a guide rail 4 are established in the longitudinal direction both-ends upper part of a case 6. Moreover, slot 6i is prepared in some cases 6. Furthermore, Slots 6e and 6f are established in the crosswise both ends of a case 6.
[0015] 7 is the cap by which plastics mold processing was carried out, and the hole (un-illustrating) in which the bearing slot (un-illustrating) which supports bearing-bar 5a to revolve, and the engagement shanks 6a and 6b are inserted is prepared. Furthermore, the pieces 7a and 7b of pinching with a stop pawl are formed in the crosswise both ends of cap 7.
[0016] Next, the interrelation of each part article is explained.
[0017] engagement hole 3a-1 prepared in the engagement shanks 6a and 6b prepared in the case 6 at the pressurization spring 3, respectively -- 3b-1 engagement (insertion) is carried out. The overhang sections 3a and 3b of the pressurization spring 3 are then bent a little by engagement shaft orientations, and the engagement shanks 6a and 6b and the fitting backlash of engagement hole 3a-1 and 3b-1 are lost. And the pressurization spring 6 is slid and stops until bending section 3c-1 and 3c-2 contact the base of a case. The amount of the maximum deflections of the pressurization spring 6 bends until the overhang sections 3a and 3b run against the stoppers 6c and 6d of a case 6.
[0018] The engagement shanks 6a and 6b of a case 6 are inserted in engagement hole 1c-3 prepared in elastic body 1c of the oscillating object 1 next, and 1c-4, respectively. Overhang section 1c-1 is then bent a little by engagement shaft orientations, and the engagement shafts 6a and 6b and the fitting backlash of engagement hole 1c-3 and 1c-4 are lost. And the oscillating object 1 is slid until it contacts piezoelectric-device 1b of the oscillating object 1 at 3d of heights of the pressurization spring 3.
[0019] Wearing immobilization of the both ends of bearing-bar 5a attached in the roller 5 by approaches, such as press fit, is carried out at bearing (un-illustrating) prepared in the cap 7.
[0020] On both sides of a guide rail 4, as the pressurization spring 3, the case 6 where the oscillating object 1 was attached, and the case 7 where the roller 5 was attached are crowded with the field of a roller 5, and the field of drive child 2a and 2b, they are attached in them. In that case, the pieces 7a and 7b of pinching which have the stop pawl formed in the cap 7 are guided to the slots 6e and 6f of a case 6, and are attached by the snap fitting. Moreover, then, it engages with the engagement shafts 6a and 6b of a case 6, and the hole (un-illustrating) prepared in the cap 7, and cap 7 is positioned with a case 6. Furthermore, as for a guide rail 4, migration crosswise is regulated by the slots 6g and 6h of a case 6.
[0021] 1d of polar-zonee [1]-1h and 1g [of sensor polar zone] - 1 or 1h - terminal areas prepared in 1 and elastic body 1c is soldered to lead wire or a flexible printed circuit board, they are pulled out in the exterior of a case 6 from slot 6i by which lead wire or a flexible printed circuit board was prepared in the case 6, and electric supply and sensing of them become possible by connecting lead wire or a flexible printed circuit board in an external drive circuit.
[0022] The drive principle of the rocking equipment of the gestalt of this operation is explained.
[0023] <u>Drawing 3</u> is drawing having shown the piezo-electric effect of a piezoelectric device. In

this drawing, 10 is a piezoelectric device and polarization processing is made from the upper part of drawing in the lower part (the direction of the drawing Nakaya mark). Moreover, polar zone 10a and 10b is given to both sides of a piezoelectric device by vacuum evaporationo processing.

[0024] Drawing 3 (a) is drawing having shown the situation when impressing - potential to polar-zone 10a at + potential and polar-zone 10b. In this case, since electric field are impressed to the direction of polarization, i.e., the direction, and the forward direction of polar-zone 10a to polar-zone 10b, the amount of elongation according to the magnitude of elongation and electric field generates a piezoelectric device in the perpendicular direction to the direction of polarization at a piezoelectric device.

[0025] Drawing 3 (b) is drawing having shown the situation when impressing + potential to polar-zone 10a at - potential and polar-zone 10b. In this case, in a piezoelectric device, since electric field are impressed to the direction of polarization, i.e., the direction, and hard flow of polar-zone 10b to polar-zone 10a, a piezoelectric device is shrunken in the perpendicular direction to the direction of polarization, and the amount of shrinkage according to the magnitude of electric field occurs.

[0026] Drawing 3 (c) is drawing having shown the situation when perpendicularly lengthening a piezoelectric device according to external force to the direction of polarization. In this case, - potential arises in polar-zone 10a at + potential and polar-zone 10b, and the potential difference according to the amount of elongation occurs.

[0027] Drawing 3 (d) is drawing having shown the situation when perpendicularly drawing in one's piezoelectric device according to external force to the direction of polarization. In this case, + potential arises in polar-zone 10a at - potential and polar-zone 10b, and the potential difference according to the amount of shrinkage occurs.

[0028] The oscillating object of the rocking equipment of the gestalt of this operation tends to excite a standing wave so that ellipse movement may occur to a drive child using these piezoelectric phenomena.

[0029] Drawing 4 is the side elevation of the oscillating object of rocking equipment. As for piezoelectric-device 1a, polarization processing is performed upwards from the lower part of drawing, and, as for piezoelectric-device 1b, polarization processing is performed to the lower part from the upper part of drawing. Moreover, elastic body 1c is connected to the ground. Thus, if the alternation electrical potential difference VA of in phase and this amplitude is impressed to polar zone 1e and 1h as shown in drawing 5 , and the alternation electrical potential difference VB of in phase and this amplitude is impressed to the constituted oscillating object 1 at polar zone 1f and 1g (however, polar zone [1e and 1h] alternation electrical potential differences differ in a phase), an oscillating object will develop various behavior according to the piezo-electric effect. For example, the behavior of the piezoelectric transducer in the time amount t1 of drawing 5 is equivalent to polar zone 1e-1h, and since the electrical potential difference of + is impressed, as drawing 6 (c) shows, shrinkage arises. Since the electrical potential difference of + is impressed to polar zone 1e and 1h and the electrical potential difference of the equivalent is impressed to polar zone 1f and 1g for polar zone [1e and 1h] applied voltage and an absolute value on the electrical potential difference of -, the behavior of the piezoelectric transducer in the time amount t2 of drawing 5 is crooked as drawing 6 (d) shows.

[0030] The behavior of the piezoelectric transducer in the time amount t3 of drawing 5 is equivalent to polar zone 1e-1h, and since the electrical potential difference of - is impressed, as drawing 6 (a) shows, elongation arises. Since the electrical potential difference of - is impressed to polar zone 1e and 1h and the electrical potential difference of the equivalent is impressed to polar zone 1f and 1g for polar zone [1e and 1h] applied voltage and an absolute value on the electrical potential difference of +, the behavior of the oscillating object in the time amount t4 of drawing 5 is crooked as drawing 6 (b) shows.

[0031] When behavior is seen by continuous time amount from the above thing, an oscillating object will show the behavior by which flexible movement (longitudinal oscillation) and a curvature movement (transverse oscillation) were compounded, and drive child 2a and 2b will draw an elliptical orbit. And the hand of cut of the elliptical orbit of drive child 2a and 2b is in agreement. Moreover, if the phase of the alternation electrical potential differences VA and VB is

reversed, the hand of cut of an elliptical orbit will turn into the above-mentioned direction and hard flow.

[0032] If slide members, such as a guide rail, are pressed to drive child 2a which performs ellipse movement as mentioned above, and 2b, driving force will occur and a slide member and drive children, such as a guide rail, will become movable relatively. If a guide rail is fixed, though natural, an oscillating object will move. Moreover, the reverse can also be carried out.

[0033] The detection approach of of the transverse oscillation and longitudinal oscillation of the rocking equipment of this invention is explained.

[0034] When the piezoelectric device deformed according to the piezo-electric effect, it mentioned above that the piezo-electricity according to the deformation occurred. Then, the sensor polar zone which can supervise the deformation of a piezoelectric device apart from the electrode for a drive on the oscillating object of rocking equipment was prepared, and how to detect transverse oscillation and longitudinal oscillation was considered. The magnitude in the time amount of the arbitration of transverse oscillation (crookedness vibration) is decided by the amount of elongation of the piezoelectric device by polar zone [in the time amount of arbitration / 1e and 1h] applied voltage (or the amount of shrinkage), and the amount of contractions of the piezoelectric device by polar zone [1f and 1g] applied voltage (or the amount of elongation). That is, it can express with the difference of the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor electrode 1g-1.

[0035] Moreover, the magnitude in the time amount of the arbitration of longitudinal oscillation is decided by the amount of elongation of the piezoelectric device by polar zone [in the time amount of arbitration / 1e and 1h] applied voltage (or the amount of shrinkage), and the amount of contractions of the piezoelectric device by polar zone [1f and 1g] applied voltage (or the amount of elongation). That is, it can express by the sum of the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor electrode 1g-1.

[0036] Drawing 7 shows the voltage waveform of SA+SB showing SA-SB showing the output voltage SB of sensor polar-zone 1g-1 when impressing the alternation electrical potential difference VA shown in drawing 5 to the polar zone 1e and 1h of the oscillating object 1, and impressing the alternation electrical potential difference VB shown in drawing 5 to polar zone 1f and 1g, the output voltage SA of sensor polar-zone 1g-1, and transverse oscillation, and longitudinal oscillation.

[0037] If an axis of abscissa is met in SA+SB, time amount is met for an axis of ordinate in SA-SB and a curve is made to draw, it will become like drawing 8 . This curve is right and expresses a drive child's elliptical orbit.

[0038] As mentioned above, it turns out that the behavior of transverse oscillation and longitudinal oscillation is known and a drive child's elliptical orbit can be expressed by detecting the output voltage SA of sensor polar-zone 1h-1, and the output voltage SB of sensor polar-zone 1g-1.

[0039] By the way, the tangential velocity of the wave front of ellipse movement changes with configurations of an elliptical orbit. For example, to P1 point [of the elliptical orbit of drawing 9 (a)] tangential velocity, P2 point [of the elliptical orbit of drawing 9 (b)] tangential velocity becomes slow, and P3 point [of the elliptical orbit of drawing 9 (c)] tangential velocity becomes quick. Therefore, supposing the elliptical orbit of drawing 9 is a motion of a drive child, by changing the configuration of an elliptical orbit, I hear that relative velocity with slide members, such as a guide rail, can be changed, and it is.

[0040] Then, polar zone It considered changing the configuration of a drive child's elliptical orbit and changing relative velocity with a slide member by changing the phase contrast and the gain of the impression alternation electrical potential difference (1e and 1h) VA and the polar zone [1f and 1g] impression alternation electrical potential difference VB.

[0041] First, the amplitude of VA and VB is made regularity (the amplitude of SA and SB is also theoretically fixed), and if the elliptical orbit when changing phase contrast is made to draw, it will become like drawing 10 -12.

[0042] the phase contrast of VA and VB in drawing 10 -- alpha (the phase contrast of SA and SB ** -- theoretic -- alpha --) the phase contrast of VA and VB in 0 degree < alpha< 180 degrees and

drawing 11 -- beta (the phase contrast of SA and SB -- theoretic -- beta --) If phase contrast of VA and VB in 0 degree < beta< 180 degrees and drawing 12 is set to gamma (the phase contrast of SA and SB is also gamma and 0 degree < gamma< 180 degrees theoretically), the configuration of an elliptical orbit will become longwise by considering as beta>alpha compared with the time of phase contrast alpha. Moreover, the configuration of an elliptical orbit becomes longwise by considering as gamma<alpha compared with the time of phase contrast alpha.

[0043] If the amplitude of VA and VB is fixed and phase contrast is changed from the above thing, the configuration of an elliptical orbit will change and the tangential velocity of the wave front of an elliptical orbit will change. That is, the tangential velocity of a drive child's elliptical orbit can be changed, and relative velocity with slide members, such as a guide rail, can be changed to arbitration.

[0044] If the phase contrast of VA and VB is set as 90 degrees and the gain of VA and VB is changed next, it will become like drawing 13 , drawing 14 , and drawing 15 .

[0045] The amplitude of the output voltage SA and SB of the sensor polar zone according to the amplitude of an impression alternation electrical potential difference is set to a3 and b3 in a2, b2, and drawing 15 in a1, b1, and drawing 14 in drawing 13 , respectively.

[0046] | If the amplitude of an impression alternation electrical potential difference is adjusted so that it may become a1|=|a2|=|a3|=|b1|>|b2|>|b3|, and each elliptical orbit is compared, compared with the time of b1, the configuration of the elliptical orbit at the time of b2 will become a little long and slender. Moreover, in the case of b3, it becomes a still more long and slender configuration.

[0047] If the phase contrast of VA and VB is set as 90 degrees and the gain of VA and VB is changed from the above thing, the configuration of an elliptical orbit will change and the tangential velocity of the wave front of an elliptical orbit will change. That is, the tangential velocity of a drive child's elliptical orbit can be changed, and relative velocity with slide members, such as a guide rail, can be changed to arbitration.

[0048] Next, the configuration about control is shown.

[0049] Drawing 16 is the circuit block diagram showing the gestalt of operation of this invention.

[0050] Dividing of the high frequency signal higher than the drive frequency outputted from the oscillator 21 is carried out to a predetermined frequency, it is changed into counting-down circuits 22 and 23 at drive frequency, and is outputted to a driver A24 and a driver B25. Drivers A24 and B25 amplify the signal acquired from the counting-down circuit, and impress it to an ultrasonic motor 1 (as specifically mentioned above, impressed to the polar zone of a piezoelectric device). Moreover, when a signal is impressed to an ultrasonic motor, it will resonate between coil 24a, coil 25b, and a piezoelectric device, and an electrical potential difference higher than the electrical potential difference inputted into drivers A24 and B25 will be impressed to a piezoelectric device. The output voltage from the sensor polar zone according to the behavior of the piezoelectric device at this time is detected, an adder circuit 27 performs A+B, longitudinal oscillation is detected, a subtractor circuit 28 performs A-B, and crookedness (width) vibration is detected. The longitudinal oscillation and crookedness (width) vibration which were detected output the result which it was sent to the phase comparator 29 and the magnitude-comparison machine 30, and was compared, respectively to a microcomputer 26. A microcomputer 26 judges the behavior of an ellipse from the inputted phase contrast and an amplitude difference, and it outputs a signal so that the behavior of an ellipse may be adjusted to a phase shifter 31 and a driver B25, respectively.

[0051] For example, the magnitude-comparison machine 30 carries out half-wave rectification of the signal of A+B and A-B shown with a sine wave function like drawing 17 (a), respectively, it is changed into a dc component, is changed into amplitude value, and compares by performing A/D conversion with a microcomputer 26.

[0052] Then, the phase contrast of input signals A and B is changed with a phase shifter 31 from the obtained gain. For example, before inputting the clock from an oscillator 21 into counter A22a and counter B23a like drawing 18 , the initial value in the direction of counter B23a is set up, and phase contrast with counter A22a is set up. Then, if a clock is inputted into Counters A and B and it is in agreement as compared with a predetermined compound value, Counters A

and B will be cleared. A phase will shift to a part for initial value, and a usual state by this. Dividing of the signal acquired from Comparator A, B-22b, and 23b is carried out with counting-down circuits 22c and 23c, and it changes into the square wave of 50% of duty ratio, and outputs to a driver A24 and a driver B25. The phase contrast of a driving signal can be changed into arbitration by this.

[0053] Moreover, a phase comparator 29 changes A+B and A-B into a square wave with a hysteresis comparator like drawing 17 (b) as compared with a reference value. The signal with which only the time amount for through phase contrast turns on EXOR29c for the changed square wave can be made, and phase contrast can be judged with the number of the reference clocks in the microcomputer within the time amount.

[0054] Moreover, from the acquired phase contrast, a microcomputer 26 changes the electrical potential difference impressed to a driver B25, and adjusts the behavior of an ellipse. For example, DC to DC converter 25a has determined the power source of Driver B. In this case, in order to control the electrical potential difference which a DC to DC converter outputs, the electrical potential difference outputted by comparator 26b of drawing 19 is controllable by the electrical potential difference which a microcomputer outputs.

[0055] By the above-mentioned explanation, it becomes possible to actually adjust the behavior (locus) of an ellipse, and it is stabilized and speed control of an ultrasonic motor can be performed.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The decomposition perspective view showing the configuration of the rocking equipment of the gestalt of this operation.

[Drawing 2] Drawing showing the sensor polar zone of the oscillating object of the rocking equipment of drawing 1 .

[Drawing 3] The explanatory view showing the piezo-electric effect.

[Drawing 4] The side elevation of the oscillating object of the rocking equipment of drawing 1 .

[Drawing 5] Drawing showing the alternation voltage waveform impressed to the oscillating object of the rocking equipment of drawing 1 .

[Drawing 6] Drawing showing the behavior of the oscillating object of the rocking equipment of drawing 1 .

[Drawing 7] Drawing showing the output voltage wave of the sensor polar zone of the oscillating object of the rocking equipment of drawing 1 , and the voltage waveform showing horizontal (crookedness) vibration and longitudinal oscillation.

[Drawing 8] Drawing which compounded the voltage waveform showing horizontal (crookedness) vibration and longitudinal oscillation.

[Drawing 9] Drawing showing the configuration of an elliptical orbit, and the tangential velocity of the wave front.

[Drawing 10] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase contrast and the gain of applied voltage.

[Drawing 11] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase contrast and the gain of applied voltage.

[Drawing 12] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase contrast and the gain of applied voltage.

[Drawing 13] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase contrast and the gain of applied voltage.

[Drawing 14] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase

contrast and the gain of applied voltage.
[Drawing 15] Drawing showing the situation of transverse oscillation and longitudinal oscillation with the output voltage wave of the sensor polar zone when changing the phase contrast and the gain of applied voltage.
[Drawing 16] Drawing showing the control circuit of the rocking equipment of the gestalt of this operation.
[Drawing 17] The circuit diagram showing a part of control circuit of the rocking equipment of drawing 16 .
[Drawing 18] The circuit diagram and timing diagram which show a part of control circuit of the rocking equipment of drawing 16 .
[Drawing 19] The circuit diagram showing a part of control circuit of the rocking equipment of drawing 16 .
[Description of Notations]
1 Oscillating Object
2a, 2b Drive child
4 Guide Rail as a Contact Object
1e-1h Polar zone as a signal input part for electric-mechanical energy conversion
1g-1, 1h-1 Sensor polar zone as a signal input part for machine-electrical energy conversion
VA, VB Impression alternation electrical potential difference
SA, SB Sensor polar-zone output voltage
26 Microcomputer

[Translation done.]